subjected. The length of the pectoral fin was also not so great as that figured by Couch. The proportions given in the specimen killed at Portland are—length of body 30 inches, length of pectoral fin 11½ inches; while in the specimen examined by me the length of body was 24 inches, and the pectoral fin 8½ inches. This latter length, however, comes quite up to that given by Cuvier for the species. He says the *Scomber thynnus* has the pectoral fin one-fifth part of its length, while the *Orcynus* has it one-third the length of the body, and that this difference is the only one between the two fishes. It will be seen, then, that 8½ inches is nearly the proportion given by Cuvier, being a little more than one-third of 24 inches, the full length of the fish.

It is fortunate that the pectoral fin was sufficiently perfect to allow of its being accurately measured, and thus enable us to record another instance of this south-of-Europe fish paying a visit to our northern shores.

It is further worthy of remark that Mr. Couch has reported the capture of the *Short-finned Tunny* (a fish never before taken on our coasts) on the 16th of August last. It would be interesting to know what causes have led these fish so far north on this occasion.

XXXII.—*Proofs of the Animal Nature of the Cilio-flagellate Infusoria, based upon Investigations of the Structure and Physiology of one of the* Peridinia (Peridinium cypripedium, *n. sp.*). By Prof. H. James Clark, A.B., B.S.*

[Plate XII.]

Whatever tends to elucidate the doubtful nature of any group of beings which stands undecided (as it were on the dividing line) between sentient and non-sentient things has an importance at the present day which would not have been deemed worthy of very grave consideration before the theories of Spontaneous Generation and what is sometimes mistakenly called Darwinism had been revived. The resurgence of these doctrines has given a prominence to the discussion of the character of the lowest, obscure forms of life, simply because, in their extreme simplicity, they hardly seem to rise above a state of inorganic nature, and their vitality is exhibited in such a guise as would readily be mistaken for the operation of exo-endosmotic, inanimate, inorganic forces. Hence the readiness, the eagerness, with which the physicists of the Materialistic school clutch at these "toys"

* Communicated by the Author, having been read before the American Academy of Science and Arts, February 14, 1865.

of the older microscopists, hoping therein to find an abundance of argument by which they may prove that rock and flesh do not incompatibly jostle each other whenever they come in contact.

Claiming, and justly too, that these extremes of the inorganic and organic bodies are naturally and incontestably related to each other through their common basis the simple elements of the chemist, it does not seem possible to the materialist that their relations should be changed or dissevered by the introduction of any modes of existence, however varied or elevated. The carbon, the hydrogen, the nitrogen, and the oxygen once being established as definite existences, they always remain C, H, N, and O, no matter under what forms or relations they may be disguised, the various *modes of being* not in the least changing the *fact* of their existence. For instance, they say, the transition from one kind of animate being to another kind is only a graduated change in the mode of existence, or of the manner of an outward expression of the relations of the component *elements* of the organism; certainly not an actual metamorphosis of the nature of these elements. To this assertion there may not possibly be any objection; but if the same explanation were urged for the transition to the Monad from the infinitesimally small, vibrating, inorganic corpuscle of the "Brownian motion," we have not come to that state of knowledge of the forces of nature to accept it so readily as in the former case. Still the growing tendency, among the philosophical chemists, to merge the vital and the inorganic forces into one would seem to be inevitably preparing us to regard such a transition as identical in kind with that which obtains among the undoubtedly organized bodies, whether animals or plants.

In this state of hesitancy to step across the vanishing line of demarcation between the animate and the inanimate, we can at least safely venture to give, in general terms, an expression of the relations of the three forms of existence. We may say that it is the *mode of existence* which constitutes the difference between the inorganic and the organic bodies, or between the two forms of organic life, viz. animals and plants; so that every fact enunciated in regard to an animal or plant is the record of a *symbol* of one of the methods of existence, or of the nature of the influences which enter into the life of the being.

From this point of view the study of these insignificants rises to the rank of the highest philosophical inquiry, and the minute wonders of the microscopist become the agents in the pursuit after the knowledge of the ways of the Infinite, which one could hardly have the temerity to smile at.

These thoughts have been suggested by the results of some investigations into the thus far doubtful animal nature of the

Cilio-flagellate Infusoria, as the Péridiniens and their congeners are designated by Claparède in his, conjointly with Lachmann, most recent publications upon the Infusoria*.

In order that the various points of the proof that the Péridiniens are undoubted animals may be comprehended in systematic sequence, it seems most desirable to present them under separate sections, each devoted to some particular vital function.

Habitat and Form.—There is probably no generic difference between the species in question here and those described and figured by Allman in the third volume of the 'Journal of Microscopical Science,' 1856, and by Claparède in the memoir above referred to; but in their specific relations no doubt they are distinct. This (Pl. XII. figs. 1, 2, 3) has an oblique pyriform outline, more than one-third longer than its greatest breadth, and hollowed on one side by a broad longitudinal depression (*d*), extending from the narrower end (P) to a short distance beyond the broadest part of the body. Not far from the narrower end the so-called flagellum (*fl*) is attached, in the middle line of the broad depression, and is so long as to project beyond the end near to which it is situated. As the narrower end (P) is always the posterior, and the broader end (A) the anterior, in the act of swimming, and the relations of the other parts of the body, such as the position of the mouth (*m*) and particularly the trend of the œsophagus (*œ*), correspond to these, the one which precedes should be called the anterior, and the other the posterior end of the body; and as such they will hereafter be designated in this article.

There are two shallow furrows which encircle the body; one (*pf*), rather broad, passes obliquely backwards and around it just behind its middle, and the other (*af*), quite narrow, encircles the broader end just in front of the termination of the broad longitudinal depression above mentioned. The whole of the body posterior to the narrower transverse furrow is clothed with vibratile cilia; but the anterior end is devoid of them, and appears to be covered by a low cap (*pc*) in the form of a segment of a sphere. In the young this cap is so shallow as to be readily overlooked during the motions of the animal. Close to the posterior end there is a large, clear vesicle (*cv*), which is quite conspicuous, even during the rapid motions of the animal. This is the *contractile vesicle*, which will be described presently. In point of sensitiveness this *Peridinium* exhibits it in almost as great a degree as *Pleuronema* and many other timid Infusoria. These are the most evident and striking features, such as readily attract the attention when the body is in motion; and moreover

* Claparède and Lachmann, "Étude sur les Infusoires et les Rhizopodes," Mém. de l'Ins. Genévois, tomes v., vi., vii. (1858–1861).

they are the chief and characteristic traits of this species. The specific name is derived from the resemblance in the form of the body to the labellum of one of the Orchidaceæ, viz. *Cypripedium.* It is very common in the freshwater ditches and slow streams about Cambridge, U.S.; and in the aquarium congregates in great numbers around decaying matter. It varies from $\frac{1}{300}$ to $\frac{1}{260}$ of an inch in length; but occasionally adults were found $\frac{1}{150}$ of an inch long. It is probable, however, that the latter were in a preparatory state, just before self-division. The colour is a uniform light brown, which resides mostly in the derm.

Contractile Vesicle.—This organ (*cv*) is so conspicuous, in the species before us at least, that one is apt to wonder why it has not been discovered before. The only reasonable excuse for this seeming delinquency would appear to be, that the animal is so incessantly active and so rapid in its motions, that a large amount of patience could hardly compensate for the want of a quiet subject. Fortunately, at the present day our lenses, even of moderate power, are constructed with such large angles, broad fields, and excellent definition, that the difficulty of keeping the Infusorian in sight, and of getting a clear decided view of its interior, is almost done away with. By strewing the glass slide with abundance of indigo, little lagoons are formed here and there, in which, when the specimens are plentiful, there is no difficulty in finding and confining any particular individual, without the necessity of a thin glass covering. In this way the motions of the body are reduced to a simple revolution on its longer axis, with an occasional inversion, end for end. The eye soon gets accustomed to the rhythmical appearance of any particular region as it comes round at each revolution, so that, by a systematic study of each and every feature, a knowledge of the whole organism may be obtained as readily as in most Infusoria. The contractile vesicle is invariably situated close to the narrower, or posterior, end of the body, but at a considerable distance from the ventral, dorsal, or lateral surfaces. At the moment just before systole it has a perfectly globular form (Pl. XII. fig. 1 *cv*), and a very sharp, strongly refracting, conspicuous contour, and occupies rather more than the middle third of the transverse diameter of the body at this point. The systole and diastole are as regular in their recurrence as in any of the ciliated Infusoria, and as conveniently observed. The systole, in perfectly fresh specimens, occurs with perfect regularity *once in forty seconds,* as numerous and carefully registered observations prove. As in other Infusoria, between diastole and systole, the vesicle is more or less irregular in outline, but gradually approximating to a spherical form. At the moment of systole it rather quickly changes from a broad spheroidal figure to one which is globular, and then contracts suddenly and rapidly until it is nearly invisible. The diastole then follows slowly, and during this it passes from a jagged rounded outline (fig. 3 *cv*) to a lenticular form (fig. 2), then to a hemispherical shape (fig. 4) with the flattened side next to the posterior end of the body, and finally, assuming a spheroidal contour, it remains quiet awhile, until the time for the next systole. If the water is not renewed, the specimens become unhealthy, which they exhibit by changing their form, and swelling up into an oval and finally a globular mass. In such a condition the systole of the contractile vesicle oftentimes occurs five or six times in a minute, and will continue at that rate even when the animal is very much flattened out, and until it bursts or falls to pieces. Tincture of opium stops the action of the contractile vesicle almost immediately, even before the rest of the body is sensibly affected by it. The effect is to swell the vesicle to an enormous size; and then, breaking through the posterior end of the animal, it expands to a dimension often exceeding that of the whole body, before it bursts.

The Mouth (*m*).—That this creature has a mouth might be premised from the manner in which particles of indigo or carmine approach and recede from the body. When the animal is moored by its flagelliform appendage (*fl*), and gyrates about it as if on a pivot, these particles of coloured food may be seen to pass along the face of the broad longitudinal depression (*d*), and, striking the body just behind its mid-region, glance off in a backward direction. At the point where the indigo strikes may be seen an obliquely longitudinal ovate opening (*m*), which leads into an elongated funnel-shaped cavity (*œ*): the former is the mouth, and the latter is the œsophagus. The mouth lies altogether within the posterior obliquely transverse furrow (*pf*), and extends from its anterior to its posterior edge, trending diagonally across the axial plane of the body, from the right, backwards, toward the left. Its anterior edge (m^1) is broad, and thence it gradually narrows to a sharp angle, which forms the posterior edge. It is so inconspicuous that in all probability it is nearly or altogether closed, except when taking in food; certainly it is not one of the prominent features of the organism, although one of the most important. When the animal is in a sickly condition, and swollen up, the mouth is easily descried; but its relations are not readily made out, because in this state the annular furrows are all obliterated; yet its connexion with the œsophagus at such a time is clearly seen. There are no appendages whatever about or belonging to the mouth; not even the flagelliform body (*fl*) has anything to do with it, but is attached to the body at a very sensible distance (fl^1) behind it. It would seem, therefore, to be dependent upon the simple cilia around it for the transfer of food to its lips. From the mouth the *œsophagus* (*œ*) passes obliquely backwards and toward the dorsal region, at least halfway through the body, and then terminates rather abruptly just before the contractile vesicle, but a little to the right side (fig. 3 *œ*) of the axial plane. At the mouth it is widest antero-posteriorly, but suddenly narrowing a little, it afterwards gradually lessens its calibre as it extends into the body, and finally ends as just described. The whole track of this channel is much more readily seen than the mouth. The food is taken in such excessively small particles that its entrance into the mouth cannot be detected with any degree of satisfaction; and a single digestive vacuole (*dv*) requires from twenty minutes to half an hour to form and fill; and although it may be comparatively quite large, even two-thirds of its fullest capacity, yet so infinitesimally minute are the particles, that even indigo or carmine is not readily seen, although it may be the only kind of food present. Beyond this point, however, these colouring-matters become rapidly visible, so that when a vacuole is fully formed, the indigo or carmine is as conspicuous as in any other Infusorian. These vacuoles are very large, in fact equalling in size the contractile vesicle; and as they form sometimes pretty far back, they are apt to obscure the latter—without doubt thus causing this vesicle to be mistaken for one of them, since they bear a certain resemblance to it. No anus was detected during these investigations, although the specimens at times were kept well fed.

The Locomotive Organs.—The most prominent among the cilia is the so-called flagellum (*fl*). This, however, is not a single filament, as has usually been asserted; but, owing to the manner in which it is used, it very naturally appears to be so. Most frequently its compound nature becomes apparent when the numerous cilia of which it is composed divide into two groups (fig. 7 *fl*, fl^1), thus simulating a double flagellum*. At other times, after having divided into two groups, they twist about each other in such a way as to resemble a sharply pointed screw, with a long drawn-out double thread. Such is the condition in which this pseudo-flagellum is most frequently seen, and then, with the best magnifying-powers, up to five hundred diameters, its compound nature is not easily recognized. But there are times when the whole group of cilia spreads out into a distinct brush, so that each individual cilium may be seen. The base (fl^1) of attachment is in the axial plane of the body, a short dis-

* Claparède (*loc. cit.*) speaks of frequently noticing that some of the Ceratiums, &c., appeared to have a double flagellum. Probably they were a group of cilia divided as here described.

tance posterior to the mouth (*m*), and distinctly disconnected from it, as has been already noticed. When not in motion, which seldom occurs, the brush lies along the median furrow (*mf*), which trends from the mouth to the posterior end of the animal; and in this position it projects for nearly half its length beyond the body. Its most ostensible use would seem to be that of a sort of rudder when the creature is swimming, and as a means of attachment when not progressing. The body may be seen gyrating and at the same time revolving on its longitudinal axis, for long periods, around a point to which the pseudo-flagellum is attached, and upon which it turns like a pivot. Most frequently, during this act, a part of the brush separates from the rest, and performs the office of an extra propeller. When the animal is darting and spinning through the water, this appendage projects obliquely from its point of attachment (as in fig. 1), and always following, with the narrower end of the body, in the rear, it seems pretty evidently to be the main agent in the various and sudden tackings to which this Infusorian is addicted, and also the axis upon which the body revolves; at least the latter whirls, repeatedly changing as quick as thought from right to left, or *vice versâ*, upon an imaginary axis, which is oblique to its greatest length, and which exactly corresponds to the trend of the flagelliform appendage when operating in this capacity. Under these conditions the animal shoots along with a compound motion, which might be described as wabbling, or like the action of an excentric wheel. Apparently in confirmation of this view, the annular obliquely transverse anterior (*af*) and posterior (*pf*) furrows trend almost exactly at right angles to this imaginary axis. These two furrows seem, at first sight, to be bands of *vibrating cilia*; and in fact it is in the line of their trend that these cilia are most readily detected, simply because they are rather more crowded along their edges than elsewhere; but an attentive examination reveals their presence all over the body, posterior to the anterior transverse furrow. Between the two furrows (*i. e.* from *af* to *pf*) they are longer than at the narrower end of the body, and at both points they have a pretty uniform length, moderate extension, and are very delicate, so as not to be easily observed when the body is in motion. At the anterior transverse furrow they appear to be a little longer than elsewhere, and, acting more or less in concert, they have the semblance of a wreath disposed along the edge of the low skullcap-like covering (*pc*) of the anterior end.

The Cuirass (*pc*).—It is pretty evident that in the species before us this is a mere dermal specialization, without any trace of indurated matter which would entitle it to the name of a genuine cuirass. Where vibratile cilia are present, no such covering can be said to exist; and as the broad anterior end (A) of the body is devoid of them, its skull-cap covering is the only portion of the derm where one could expect to find a cuirass. But this it is only in form, since it participates with the rest of the body in the general expansion when an individual is dying. It has, without doubt, a different character from the rest of the skin; for the style of ornamentation is not of the same kind, and, curiously enough, too, it is less truly ornamented than the other regions of the body, amounting to a mere scattered punctuation; whereas over the field where the cilia prevail these punctuations, which are in reality minute, cylindrical, strongly refracting bodies standing perpendicularly to the surface of the derm, are arranged in perfectly regular rows, which have a different character in the three regions posterior to the pseudo-cuirass. In the space (fig. 5 D) between the anterior (*af*) and posterior (*pf*) transverse furrows, the rows trend longitudinally and transversely; in the posterior transverse furrow (*pf*) they have the same arrangement as the last, but they are more closely set together; and in the region behind the latter furrow they trend in decussating lines (P), like those in the carapace of *Arcella vulgaris*.

This region is also characterized by being divided longitudinally, on the ventral side, by a furrow (fig. 1, 2, 6 *mf*) which trends in a direct line from the end of the body to the mouth, and gradually widens anteriorly, where it joins the annular transverse furrow (*pf*). At this point of juncture the flagellar appendage arises, and opposite to it the anterior edge of the transverse furrow just mentioned forms an inequilateral angle at the broader margin (m^1) of the mouth, so that the right and left halves of this furrow are rendered asymmetrical—a character in perfect accordance with that of many, if not of all, the *Peridinia*.

The Nucleus (*n*).—At the period when these observations were made, viz. early last December, the genital organ invariably lay transverse to the longitudinal axis, and occupied a very large portion of the bulk of the posterior end of the body. Most frequently it had a U-shaped form (fig. 3 *n*), and embraced the contractile vesicle with its two limbs. It was then of a yellowish-brown colour, and perfectly homogeneous. Occasionally it was observed to be divided into three or four masses, which extended toward the region encompassed by the posterior annular furrow. While in the U-shaped form, the whole semiopaque mass was enclosed in a transparent envelope (*ne*). Oftentimes there was to be seen immediately over and close to the dorsal region of the nucleus, and directly in the plane of the axis of the body, a minute, clear, vesicular corpuscle (fig. 3 *t*), which seemed to have the character of a "nucleolus" or (as is now becoming the belief, since the investigations of Balbiani and Claparède) a *testicle*.

Reproduction from the egg has not been observed, but transverse division occurred in a number of instances. In the latter case it agrees, in the process, with what Allman (*loc. cit.*) has described, excepting that the resultants (fig. 6, I. II.; fig. 7) are quite different in their proportions from the adults (figs. 1, 2, 3). At the moment of separation the young offshoot (fig. 7) is about two-thirds the size of the adult, and is almost as broad as long, and bulges strongly on the ventral side (V), in front of the mouth (*m*). It has a very flat anterior end, and the pseudo-cuirass (*pc*) of this part is represented by an inconspicuous unguiform body. The anterior transverse furrow, on account of its narrowness, hardly attracts attention, except along its ventral edge (*af*), where it is rendered conspicuous by the strong projection of the unguiform cuirass. As in the adult, it is broadest ventrally, but, growing shallower, thins out (af^1), going dorsally to almost nothing. The relations and structure of the various organs, cilia, &c., are the same as in the full-grown individuals; but with progressing growth the proportions of the different regions of the body change insensibly, as may be seen by comparing figures 7, 4, and 1, which are respectively representations of the youngest, middle-aged, and adult individuals.

EXPLANATION OF PLATE XII.

[In all the figures the same letters refer to corresponding parts.]

A. The anterior end of the body. P. The posterior end.
D. The dorsal side. V. The ventral side. R. The right side. L. The left side.

af, anterior transverse or annular furrow; af^1, dorsal part of *af*; *pf*, posterior transverse or annular furrow; *mf*, median or longitudinal furrow; *d*, depressiou on the ventral side; *cv*, contractile vesicle; *m*, mouth, m^1, anterior edge of *m*; *œ*, œsophagus; *dv*, digestive vacuoles; *fl*, pseudo-flagellum, fl^1, base of *fl*; *n*, nucleus or generative organ; *ne*, envelope of *n* (this is the reproductive organ, properly speaking, and *n* is the contents or reproductive material, the future eggs); *t*, nucleolus or testes; *pc*, pseudo-cuirass.

I., II. The two products of self-division. III. The annular constriction which finally separates I. and II.

Figs. 1 to 7. *Peridinium cypripedium*, n. sp.
Fig. 1. Profile of an adult, seen from the left side; magn. 500 diams.
Fig. 2. View of the ventral side of an adult; magn. 500 diams.
Fig. 3. Posterior view of an adult, the anterior end in the distance; magn. 500 diams.
Fig. 4. A young individual; magn. 300 diams.
Fig. 5. An adult, gradually dried up; dorsal view, to show the arrange-

ment of the punctiform ornamentation of the derm; magn. 500 diams.

Fig. 6. The process of self-division, just half an hour before separation; ventral view; magn. 200 diams.

Fig. 7. Profile of I. fig. 6, just at the moment of separation; magn. 200 diams.

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Travels and Researches in Crete. By Captain T. A. B. Spratt, R.N., C.B., F.R.S. &c. In two vols. 8vo. London: Van Voorst, 1865.

In carrying out the Mediterranean Survey, the Island of Crete came under examination by Capt. Spratt, whose acquaintance with the requirements of his own profession, with the ancient and modern history of the Greeks, their early works of art, coins, monuments, and buildings, with the natural history of land and sea in the Mediterranean area, and with the geological structure of every mountain, coast, and islet he visited, render him peculiarly capable of doing justice to so interesting a region as Crete. The form and character of that island, from mountain to plain, the sites of its cities, its ravines, caves, and water-courses, are so visibly explicable by their rocky structure, that to shut one's eyes to their geological is to misinterpret their topographical relations. Its highlands and valleys, as well as the coast and the deep sea, are strikingly remarkable in their natural products. Its old forgotten cities rise up to intelligent research, and the ancient ruins take definite form and their true place in history, when learning and sagacity unravel the half-true legends of the place. In Crete are found statuary and coins of the finest style, and of a school dating from an earlier time than Athenian art could boast of; for it was the cradle of Greek learning and much of Greek mythology. Lastly, there still exist genuine Cretan Greeks, whose ancestors (under the Roman sway) heard Paul preach at Fair Havens,—under the Byzantines, Saracens, Franks, and Venetians, played their mediæval part in quarrels, bigotry, and trade, and, well versed in war, withstood the Turk for more than twenty years,—and under the Turk have suffered all that brings out the debasing vices and exceptional virtues of a conquered race.

Following Capt. Spratt in his account of Crete (the eastern part of which he more particularly treats of, as having been left undescribed by Pashley), we find the natural features of the country, the remnants of Greek buildings and works of art, mediæval relics, the peculiarities of the present population—the old highland Sfakiote breed, hardy, unscrupulous, and cruel, and the lowland Candiotes of mixed origin—all carefully noted and elucidated by a scientific acquaintance with nature and by a knowledge of classic literature and history; whilst an eye for beauty in nature and art—enthusiasm in working out the traces of long-past civilization, the early source, in great part, of our present culture—a warm sympathy with all